Age of Acquisition (AoA) effect in monolingual Russian and bilingual Russian (L1) - English (L2) speakers in a free recall task

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Key words: Age of Acquisition; monolingual Russian; bilingual Russian-English; free recall; pictures and picture names

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Abstract

AoA is a unique psycholinguistic variable because of its link to the semantic architecture of the mental lexicon (e.g., Brysbaert, Wijnendaele & de Deyne, 2000). The role of AoA on free recall has been examined in English (Coltheart & Winograd, 1986; Dewhurst, Hitch & Barry, 1998) and recently in Turkish (Raman, Raman, Ikier et al, under revision) with contradictory outcomes. While an overall advantage was found for late acquired items in English, the contrary was reported in Turkish. Furthermore, this effect appeared to be modulated by frequency and whether items were presented in pure or mixed lists. The present study extends Raman et al study to monolingual Russian and bilingual Russian (L1) – English (L2) speakers in order to understand the extent to which AoA affects free recall. One interesting aspect of Russian writing system is that it consists of Cyrillic and Roman letters, hence creating a shared orthographic medium in Russian-English bilinguals. Participants were allocated to either picture or word condition and subsequently to either pure list or mixed list condition. Both monolingual Russian (N=42) and bilingual (N=40) Russian (L1) – English (L2) data show a robust main effect for AoA in free recall irrespective of list type for words and for pictures and no significant interactions. Overall, early acquired words and pictures had an advantage over late acquired items. These findings are contrary to what has been reported in the literature for monolingual English speakers (Dewhurst et al, 1998) but in line with findings for Turkish (Raman et al, under revision) and will be discussed within the monolingual and bilingual theoretical frameworks.

Key words: Age of Acquisition; monolingual Russian and bilingual Russian-English; free recall; pictures and picture names; bilingual memory

Introduction

The past 40 years has been marked by a rapid growth of studies focused on understanding the role of AoA on lexical and semantic processes as well as why this is the case. The first study on AoA was conducted by Rochford and Williams (1962) who found that the age at which children were able to name pictures correctly was correlated with a proportion of aphasic patients with who were also able to successfully name the same pictures. In a classic study, Carroll and White (1973) asked 20 adult participants to indicate an age when they believed they learned each word given using an 8-point rating scale (1 = age of 2-3 years to 8 = 14 years and older). The list of words was controlled for frequency effect. A significant difference was reported between words which were reported to be learnt earlier in comparison to those learnt later in life, showing that objects whose names were learnt early were named faster. On the contrary, there was no frequency effect. It was assumed that the age at which a word was learned had an influence on naming latency, and that word frequency rather was incidentally associated with naming latency. Carroll and White (1973) concluded that 'memories for words, and possibly other items, are stored according to a chronological dimension rather than a frequency dimension' (pp. 91-92). This led to a number of questions and debates around the subject of AoA, such as the relationship between AoA and frequency. Questions were also raised as to whether AoA reflected cumulative frequency. Various theoretical explanations were proposed to explain the AoA phenomenon including a proposition that earlier acquired words are more accessible for retrieval due to their organisation in deeper levels of cortical representation than words acquired later (see Johnston and Barry, 2006 for an overview). It was suggested that early acquired words are in a privileged position because they are represented bilaterally in the brain whilst late acquired words mostly are represented in the cortical area responsible for speech. However, this theoretical account has been confidently dismissed by a number of studies that failed to show any cortical asymmetry for early vs. late acquired words (e.g. Boles, Rogers and Wymer, 1982; Ellis and Young, 1977).

Subsequent studies on AoA led to its acceptance as an influential variable that had to be taken in consideration in lexical processing (e.g. Gilhooly and Logie, 1980; Gilhooly and Logie, 1981; Gilhooly and Watson, 1981). Gilhooly and colleagues employed word recognition, word naming and memory tasks to explore AoA effects as a secondary variable. Morrison, Ellis and Quinlan (1992) replicated Carroll and White's (1973) study and confirmed that AoA but not word frequency affects picture naming. The same result was later reported for word naming (Morrison and Ellis, 1995). However, it was not until Morrison and Ellis (1995) claimed the

significance of AoA as an influential variable more so than frequency that led to the significant research in AoA.

Theoretical Accounts of AoA

An increased interest in the AoA effect led to the development of theoretical consideration that generated the following questions: What is the mechanism responsible for the emergence of the AoA effect? What is its locus in the lexico-semantic system?

One of the early theoretical accounts came from Brown and Watson (1987) who suggested that early acquired words are phonologically more complete in the mental lexicon than late acquired words. For late acquired words 'only minimal information is stored explicitly' (p. 215) which was explained by a limited storage capacity of memory. Conversely, early acquired words were assumed to be accessed quicker when produced for naming. The phonological completeness hypothesis faced difficulties explaining the mechanisms of existence of the AoA effect in lexical decision, semantic priming and face recognition tasks (see Johnston and Barry, 2006 for a review). A direct test of the phonological completeness hypothesis was conducted by Monaghan and Ellis (2002a) who assumed that if early acquired words were phonologically more complete than late acquired words then it would be more difficult to segment them. The authors tested three conditions of phonological segmentation in a deletion task, that is, participants were required to delete either a phoneme (e.g <frog> = delete initial phoneme /rog/), onset (e.g. <spoon>= delete onset /oon/) or first syllable (e.g. <havoc> = delete first syllable /voc/) deletion. In contradiction to the phonological completeness hypothesis, no reliable differences were found between early and late acquired words.

One explanation that came about as a consideration of the locus of the AoA effect was the semantic hypothesis (Brysbaert, Wijnendaele, and de Deyne, 2000). Most authors have explained AoA effects, particularly in word naming tasks, as having a lexical locus of origin not taking into account semantic representations of words and objects (see Johnston and Barry, 2006 for comprehensive review). However, language processing is a complicated process that typically requires involvement of both lexical and semantic representations. The semantic hypothesis assumes that the magnitude of AoA effect will be higher in tasks that require access to semantic level of language processing. The main assumption is that semantic processing will be faster and more accurate for early acquired words because they are assumed to enter the representational system first and later acquired words were built up upon them, i.e. stronger semantic networks for earlier items. Hence, early acquired words influence the way late acquired words are represented. Brysbaert and colleagues (2000) have employed a variety of semantic task to test this hypothesis. For example, Brysbaert et al (2000) showed that the time needed to

create a semantic associate was faster for early acquired words than for the words acquired later in life.

It is important to note at this stage that accounts for AoA introduced above were based on mostly on behavioural data explained within localised representations in the mental lexicon. Connectionist accounts of language processing were also developed to account for AoA effects. One such perspective is the cumulative frequency hypothesis (Zevin and Seidenberg, 2002) which critiqued word naming experiments from a methodological perspective. The main critique was that previous studies did not control cumulative frequency, that is, the total number of exposures to a word. According to this model, learning is age-limited and that words learned earlier are encountered to more frequently through life.

According to Zevin and Seidenberg (2004) 'AoA norms are a surrogate variable for the several aspects of words, including frequency trajectory as well as semantic and phonological factors, that determine when they are learned' (p.32). In other words, early required words are processed faster and more accurately due to the fact that they encountered more often in life than late acquired words (Carroll and White, 1973; Lewis, Gerhand and Ellis, 2001). This means that AoA effects could be associated with a residence time of the word in memory and a number of times a participant encounters a word through their life (Johnston and Barry, 2006). The relationship between AoA and frequency is inevitable given they are entwined variables but it has been demonstrated that AoA and frequency can yield orthogonal effects in studies that use carefully selected materials (e.g. Cortese and Khanna, 2007; Ghyselinck, Custers and Brysbaert, 2004; Menenti and Burani, 2007).

In brief, AoA has been empirically documented in a large number of studies (e.g. Belke, Brysbaert, Meyer and Ghyselinck, 2005; Cortese and Khanna, 2007) and compared to frequency effects (e.g. Gerhand and Barry, 1998; Morrison and Ellis, 1995). Although the correlation between word frequency and AoA is high nevertheless AoA effect cannot be explained by one variable (cumulative frequency) only.

The arbitrary mapping hypothesis was proposed as an alternative account of AoA effects at about the same time as the semantic hypothesis (Ellis and Lambon Ralph, 2000). The authors explored the AoA effect using simulations from their connectionist model and assumed that AoA can affect multiple stages during word recognition. Early acquired items configures the network into the most advantageous to them, but late acquired items struggle to reach the same level of differentiation because the network 'becomes increasingly stable and rigid, showing a resultant decrease in its capacity to assimilate new patterns' (p. 1108). Ellis and Lambon Ralph claimed that if the mapping between input and output items is inconsistent (in case of reading

irregular words) or arbitrary (when learning new object names) AoA effect will be larger for late acquired items.

Further simulations by Monaghan and Ellis (2002b) found evidence for the arbitrary mapping hypothesis where AoA effect was found for inconsistent (irregular such as <colonel>, <yacht>) items only. The prediction was made the AoA effect is mostly larger when the input and output items are arbitrary (inconsistent). The arbitrary mapping hypothesis postulates that the AoA activates the representational level between the input and output. It means that the strength of the AoA depends on how large the arbitrary mapping is. This principle is correct for tasks including naming pictures and their names where orthography to phonography representations are assumed to be arbitrary such as irregular English words.

The arbitrary mapping hypothesis provides a strong explanation for the AoA effects typically found in late acquired, low frequency irregular English words which are more likely to have arbitrary mappings between orthography to phonology. However, it does not predict an AoA effect where mappings between orthography and phonology are non-arbitrary, i.e. direct or systematic or predictable. Using the extremely predictable and transparent representations between orthography to phonology in Turkish, the claims of this hypothesis were put to the test in a word naming task (Raman, 2006). Although previous reports of significant AoA effects emerged from other relatively transparent orthographies such as Dutch (Brysbaert et al, 2000) Turkish presents a much more transparent orthography in order to put to the claims of the arbitrary mapping versus semantic hypothesis to the test. Raman (2006) reported a significant main effect for AoA in a naming task in Turkish which was taken as evidence that AoA effects were not specific to arbitrary mappings but 'an inherent property of the functional architecture of lexical processing, thus a universal factor similar to word frequency effect' (Raman, 2006, p1049). Moreover, this effect was replicated in picture and word naming with adult dyslexic university students (Raman, 2011) further confirming the earlier conclusion.

As reported above, AoA effects have been investigated in a variety of lexical and semantic processing tasks. This effect has been reported in a number of tasks that require lexical retrieval, for example word naming tasks. Moreover, the AoA effect is found in tasks that do not require lexical retrieval, such as object recognition tasks, discussed below. Overall, AoA effects are found in a variety of domains including written naming, word pronunciation tasks, face recognition, recognition memory and free recall tasks (see Johnston and Barry, 2006 for reviews). A few studies employing lexical decision tasks have shown that early acquired words are recognised quicker and more efficient than words acquired later when they have to be

distinguished from nonwords (Morrison and Ellis, 1995; Nagy, Anderson, Schommer, Scott, and Stallman, 1989).

One important note is that the review of AoA literature thus far has been limited to mostly monolingual experiments with the exception of Izura and Ellis (2002; 2004) who challenged the claims of the semantic hypothesis by presenting evidence from bilingual L2. According to Izura and Ellis (2004), AoA effects in L2 depend on the age at which the word has been acquired in second language (L2) but not on the age at which corresponding L1 words was learnt. Therefore, this has been interpreted to mean that semantic representation is shared between two languages and this fact challenges the semantic hypothesis.

In a further bilingual study, Izura and Ellis (2002) employed picture naming and lexical decision tasks to study AoA effects in both L1 (Spanish) and L2 (English). Spanish (L1) - English (L2) bilinguals were asked to rate the age at which they thought they first learnt Spanish words. The result of the experiment replicated AoA rating collected from monolingual Spanish speakers. The bilinguals were also asked to rate at what age they learnt English words (L2). The results showed that AoA has an effect on picture naming and lexical decision times in Spanish (L1) as well as on bilinguals' picture naming and lexical decision times in English (L2). A multiple regression analysis demonstrated that the AoA L2 effect was independent from the AoA L1 effect and native language did not contribute to the ratings of L2 AoA. To confirm this result Izura and Ellis (2002) compared lexical decision times separately for early acquired words learned in Spanish and for their English equivalents acquired later in life (e.g. <zapatillas> (L1) – <slippers> (L2)). The analysis showed that when participants responded to the words in Spanish (L1) they responded quicker to early acquired Spanish words than to the words acquired later in English (L2). The opposite tendency was registered when participants were asked to respond to the words in English. That is, even if overall their time reaction was slower, they nevertheless responded faster to the English (L2) early acquired words than to the late acquired words in Spanish (L1). The AoA effects were confirmed to be language specific showing that order of L2 acquisition is a crucial factor. In contrast to monolingual speakers, bilinguals can start L2 acquisition after the "critical period". Izura and Ellis (2002) argue that significant neurological changes happen after this period which can hinder L2 acquisition but a number of bilingual speakers start to acquire L2 much later than the L1, that is, after the "critical period". Studies of bilingual language processing must therefore control for the age of L2 acquisition and/or proficiency where possible.

Returning to the current study, one important note is that Russian children start to learn English approximately between 8 to 10 years of age and continue to learn English as L2 until

graduation from high school at the age of 17. However, with higher demands on bilingualism and fluency in English a portion of high school graduates continue to study English.

AoA, Memory and Context

Although AoA effect is a widely observed phenomenon in lexical and semantic tasks, its role on memory tasks is not that obvious. One such task, free recall, is used for exploring the organisation of episodic memory. Under the free recall task, participants are typically presented with a list of items (words, pictures) to be learnt and after a distractor task, asked to recall as many items as possible from the list. The free recall task has been instrumental in investigating the influence of AoA especially whether it is involved in the organisation of episodic memory.

One of the pioneering studies in this respect was conducted by Morris (1981) who used a list of early and late words mixed together. Morris (1981) reported that late acquired words were better recalled than early acquired words. This finding was counterintuitive as early acquired items are expected to have stronger representations in memory. The study was replicated by Coltheart and Winograd (1986) in a pure list condition who reported null AoA effect. Dewhurst, Hitch and Barry (1998) combined the experimental methods used by Morris (1981) and Coltheart and Winograd (1986) in an experiment employing both a mixed list and pure list design. Dewhurst et al (1998) reported a significant main effect for AoA in in the mixed list only. Participants managed to recall more late acquired than early acquired words; and more words of low than high frequency words. The results were taken to indicate that AoA effect was a modifiable effect prone to context effects (i.e. list effects) and that late acquired words appeared to influence the encoding hence the retrieval of episodic memory differently (perhaps with stronger, more permanent semantic representations) than early acquired words. In the pure list condition, Dewhurst et al (1998) reported only a significant frequency effect which was reversed, that is, participants were better at recalling high frequency words compared to low frequency words. AoA effect was nonsignificant in the pure list condition and no interaction between the two variables. Dewhurst et al concluded that 'Findings were attributed to the more distinctive encoding of low-frequency and late-acquired words' (p284). Even if this supposition could be true for English, it is difficult to define, operationalise and manipulate 'distinctive encoding' in other orthographies especially one such as Russian that is based on two alphabets.

The advantage for late acquired words was also reported in two influential mega recognition studies in English by Cortese and colleagues (2010, 2015). The aim of these studies was to test recognition memory for monosyllabic (Cortese et al, 2010) and disyllabic (Cortese et al, 2015) words in 120 subjects. Participants studied 30 lists of 50 words and were tested on 30 lists of 100 words. Item-level multiple regression analyses was applied to analyse hits, false

alarms, hits minus false alarms; subjective frequency, imageability, orthographic similarity, AoA and word length were predictor variables. One of the findings showed that AoA positively correlated with hit rates and negatively correlated with false alarm rates, and the late acquired words had an advantage over the early acquired items.

It has been long known that the particular way stimuli are organised have been demonstrated to influence the behavioural outcome in experiments designed to measure lexical and semantic processing. Historically, Frederiksen and Kroll (1976) are reported to be the first to investigate the role of list type on RTs in single-word naming. Frederiksen and Kroll (1976) proposed that under pure list conditions (e.g., early acquired words only), readers are encouraged to optimize the use of a particular process speeding up RTs. In comparison, in a mixed list which comprises of at least two types of stimuli (e.g., early and late acquired words), RTs would slow down. Although several accounts have been proposed for the differences observed in the pure vs. mixed lists over the decades, one possible explanation is the change in strategies a reader may adopt under task demands (see Lupker, Brown and Colombo, 1997 for a review on context effects particularly in English). Few studies on other languages such as Persian (Baluch and Besner, 1991) and Turkish (Raman, Baluch and Besner, 2004) have also yielded similar results.

Until very recently, AoA effects on the free recall has been limited to English only (Morris, 1981; Coltheart and Winograd, 1986; Dewhurst et al, 1998). Previous research on Turkish (Raman, 2006; 2011; Raman et al 2014) reporting a significant and reliable effect for AoA in naming was extended to free recall. Raman et al (under revision) partially replicated Dewhurst et al study by examining the role of AoA on free recall of pictures and their names (words) in Turkish and have reported contradictory findings to word recall in English. Raman et al are the first to include pictures in a free recall task in order to examine AoA effects.

Russian Orthography and Its Significance for Research

Modern Russian is a widely spoken East Slavic language which belongs to the Indo-European family of languages. According to Kerek and Niemi, (2009a) the structure of the Russian orthography is complicated by exceptions and hierarchy of system of rules. The complexity of the language lies in its morphology. One of the main features of the grammatical structure of the Russian language is a mandatory change in the form of words according to the gender, number and other factors, and in the formation of phrases and sentences these words has to be coordinated accordingly. The primary means of producing synthetic forms of words in the Russian language is the ending. Endings are formed by means of the form of nouns, adjectives,

numerals, pronouns. In most cases, the endings turn out to be syncretic, that is expressing more than one grammatical meaning.

Despite the complex Russian orthography, Russia has one of the highest levels of adult literacy in the world in 2009 (Huebler and Lu, 2013). There are a number of the features of Russian orthography and morphology that affect the process of literacy acquisition (Cubberley, 2002; Kornev, Rakhlin and Grigorenko, 2010). This is partly attributed to the Russian letter-sound correspondences which involve a small number of context-dependent rules which can be difficult for beginner readers.

Russian orthography is reported to be more phonemic in comparison to English (Grigorenko, 2012) and is morphologically very complex. Phonetic modifications, consonants and a number of irregularities prevent readers to perceive a morpheme as a distinct unit (Kerek and Niemi, 2009b). Russian language is one of the most widely used languages but research body based on the study of the Russian language is relatively small (Kerek and Niemi, 2009b). Language features that combine the complexity and regularity is what makes Russian writing system important for between-language research, particularly with English as there are shared features between Russian (Cyrillic and Roman) and English (Roman) orthographies. As can be seen in Table 2, Modern Russian alphabet is a mixture of Cyrillic and Roman orthographies and consist of 33 letters: 6 letters are orthographically and phonologically shared with English (Roman) writing system; 7 letters are orthographically shared, but phonologically unique; 14 letters are orthographically unique, but phonologically shared and finally 6 Cyrillic letters are orthographically and phonologically unique.

Recent developments saw the emergence of the first normative data in Russian Tsaparina, Bonin and Meot (2011) using the colour version of the Snodgrass and Vanderwart (1980) pictures (Rossion and Pourtois, 2004). Tsaparina and colleagues (2011) reported norms for name agreement, image agreement, conceptual familiarity, imageability, and age of acquisition in Russian. The word frequency counts were included in the Tsaparina et al (2011) study and were taken from the New Frequency Dictionary of Russian Vocabulary incorporating over 150 million words (Lyashevskaya and Sharov, 2008). All the participants were native Russian speakers living in St. Petersburg. In total 181 participants took part in the research, 31 of them participated in the AoA rating task. The particular interest for the current research programme is the procedure employed for the collection of AoA subjective ratings from participants. In the AoA rating task participants were asked to estimate the age they thought they

learned names of the pictures presented. AoA was rated on a 5-point scale and divided into ranges of 3 years (0–3 at one extreme and 12+ at the other). The values were then converted to numerical values, with 1 = learned between 0–3 years and 5 = learned at age 12 or after. The obtained normative database for pictorial material is useful for further research in memory, language production and language processing in adult Russian speakers.

In addition to the behavioural studies reported above, neuroimaging studies by Marian, Spivey and Hirsch (2003) on Russian (L1) – English (L2) bilinguals examined whether shared and separate systems exist in word recognition using eyetracking and fMRI. A series of three eyetracking studies suggested that, at early stages of word recognition, bilinguals activated both languages in parallel, even when direct linguistic input is in one language only. Authors suggest that parallel activation (as found with eyetracking) and shared cortical structures (as found with fMRI) may be characteristic of early stages of language processing (such as phonetic processing), but the two languages may be using separate structures at later stages of processing (such as lexical processing). It is important to note that Marian and colleagues (2003) recruited early bilingual Russian (L1) – English (L2) when the current study recruited late Russian (L1) – English (L2) bilingual speakers.

To conclude, a review of the literature on experimental research attempting to understand the cognitive processes of Russian monolingual as well as bilingual speakers showed that this is still in its infancy. Russian presents a unique orthography which will be employed for the first time to address the research questions raised here with the purpose of establishing a theoretical account of the architecture of lexical and semantic processes in monolingual Russian and bilingual Russian (L1) - English (L2) speakers, as well as memory, using experimental paradigms such as naming tasks and free recall tasks.

The rationale of the study is rooted in an attempt to shed further light to the role of AoA in a free recall task using the characteristics of Russian in monolingual and bilingual populations. Given that Russian is said to be more phonemic than English (Grigorenko, 2012), and if orthographic transparency is a contributing factor in free-recall, the findings from Russian are predicted to be more in line with those reported in Turkish than in English such that overall an advantage for early items will be found in both monolingual and bilingual groups. Moreover, this pattern of results would also be supported by Izura and Ellis' (2002) Experiment 1 findings

from AoA in Spanish-English bilinguals although the experimental paradigm used was different (picture naming task).

In a partial replication of Raman et al (under revision), pictures will be used together with their names (words) to explore if AoA affects free recall of words and pictures to the same extent. It is well documented in the literature that information is more likely to be recalled when it is presented in pictures compared to in words (Paivio, 1971; Rajaram, 1996). This view is based on the functionalist account of human memory (Nairne, 2010) which considers the fact that the processing pictures precede the processing of language (e.g., words) in the evolution of human memory (Paivio, 2007).

Experiment 1: The role of AoA on monolingual Russian speakers in a free recall task

The aim of the experiment was to investigate the AoA effect on words and picture free recall in Russian monolinguals. This is because there are no previous reports on AoA in Russian bar two recent normative studies (Akinina et al, 2015; Tsaparina et al, 2011). It is therefore of importance to establish that AoA effect in free recall exists in monolingual Russian speakers before turning our attention to bilingual Russian (L1) –English (L2) speakers.

One further aim of Experiment 1 was to ask participants to rate the age when they thought they learnt the items after they completed the experimental task. The data were subsequently used to validate the norms reported in the literature and to ensure their reliability.

Method

Design

A factorial design using a 2 (AoA: Early, Late) x 2 (Stimulus type: picture, picture name/word) x 2 (List type: pure, mixed) where AoA was a within subject variable and Stimulus type and List type were the between subjects conditions. The raw scores on correctly recalled items was the dependent measure.

Participants

A total of 42 monolingual Russian speakers who were university students were recruited from St. Petersburg State Paediatric Medical Academy in St. Petersburg, Russia. Participants were allocated to experimental conditions as follows: 11 in pure word list and 10 in mixed word list; 11 in pure picture list and 10 in mixed picture list.

Materials

A total number of 50 experimental stimuli were selected from the Russian normative data developed by Tsaparina et al (2011) based on the colour picture norms (Rossion and Pourtois,

2004) of the original Snodgrass and Vanderwart black and white line drawings (1980). The Russian norms were standardised for age of acquisition and subjective word frequency along with name agreement, image agreement, conceptual familiarity and imageability (Tsaparina et al, 2011). Pictures and their names (words) were selected to be used in the picture and word recall respectively.

Early and Late AoA items were carefully selected based on the following analyses: In total 50 pictures (and picture names), half of which were early acquired and the other half late acquired items were used. The early acquired picture mean score was 1.5 (SD=0.16); the late acquired mean score was 2.6 (SD=0.64). This means that early items were acquired by approximately 5.5 years of age, and late items were acquired approximately at the age of 9. A comparison of early acquired with late acquired words showed a significant difference, $t(24)=11.23$ $p<0.0001$, therefore upholding their status.

Mean Frequency counts were also computed for early acquired items (111.66 per million) and late acquired items (24.08 per million). Stimuli used in Experiments 1 and 2 can be seen in the Appendix together with corresponding English translations and AoA ratings from various norms.

For monolingual participants the rating data for 50 items were entered into a correlational analyses using Pearson's which found a significant relationship between the current ratings and Tsaparina et al (2011) AoA norms [$r(50)=0.63$ $p<0.0001$]. Moreover, a significant correlation was also found between the current ratings and those reported recently in a large normative study for 25 languages (Luniewska et al, 2016) for 29 items, $r(29)=0.74$ $p<0.0001$.

Procedure

The study commenced after ethical approved was granted by the Psychology Ethics Committee at Middlesex University and permission was given by the St. Petersburg State Paediatric Medical University. Participants were tested one by one in a single session after giving informed consent in a quiet room located at the Department of Clinical Psychology, at St. Petersburg State Paediatric Medical University.

Participants were presented with a list of 50 pictures or picture names (words) under pure or mixed conditions. The stimuli were presented using a PowerPoint presentation with each picture or picture name (word) shown for 2000ms followed by a 1000ms interval before the next stimulus was presented. In the first or learning phase of the experiment, participants were randomly allocated to either a mixed list or a pure list condition. Under the mixed condition early and late acquired items were randomly mixed. In the pure list condition two blocks were

created, one for early and the other for late acquired items. The presentation of the two blocks was subsequently counterbalanced in order to avoid order effects. Once participants saw all the items, they were given a simple mental numerical exercise to count backwards from 999 in 3s for three minutes. This was to avoid a recency effect, that is, the memorisation of the last items on the list. Finally, in the recall stage of the experiment participants were provided with a blank sheet of paper and asked to recall as many items as possible.

After the completion of the experimental task, participants were given a rating sheet with all the experimental stimuli and were asked to estimate the age at which they had acquired each of the items. The AoA ratings were based on Tsaparina et al (2011) norms.

Results

The data analyses on the number of correctly recalled items were conducted using descriptive and inferential statistics by way of a 2 (AoA: Early, Late) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) mixed ANOVA.

Insert Table 1 here

The results show a robust main effect for AoA effect in free recall irrespective of list type for words [$F(1,19) = 9.44$ $p < 0.006$)] and for pictures [$F(1,19) = 46.9$ $p < 0.0001$). None of the interactions reached statistical significance. It is interesting to see that the findings are contrary to what has been reported in the literature for monolingual English speakers (Dewhurst et al, 1998) but in line with findings reported for Turkish (Raman et al, 2015; under revision). To the best knowledge of the researcher, this is the first report of AoA effect in Russian in a free recall task for words and pictures. The implications of the findings will be discussed fully under general discussion in view of current theoretical perspectives of AoA.

Experiment 2: The role of AoA effect in bilingual Russian (L1)- English (L2) speakers in a free recall task

The aim of Experiment 2 was to replicate Experiment 1 by employing bilingual Russian (L1) – English (L2) speakers in order to address the issue of whether AoA is involved in the organisation of memory in L1 and L2. The method was almost identical to Experiment 1 with the main difference being the addition of picture name (word) stimuli in English (L2).

Design

Experiment 2 employed a factorial design with a 2 (AoA: Early, Late) x 2 (Language: Russian or English) x 2 (Stimulus type: picture, picture name/word) x 2 (List type: pure, mixed) conditions. The AoA was within subjects and Stimulus type, List type and Language were between subjects conditions. The participants were presented with either a list of picture names

(words) in Russian (L1) or in English (L2) separately. The number of correctly recalled items was used as the dependent variable.

Participants

The participants were bilingual Russian (L1) – English (L2) university students (N=40) recruited from St. Petersburg State Paediatric Medical Academy in St. Petersburg, Russia participated in the experiment. None of the participants studied English before the age of 8 years and all of the participants were proficient L2 speakers who continued to learn English at least until the age of 17 or later. The language proficiency was measured using the Schonell Reading Test (1971).

The allocation of 21 participants to conditions in Russian (L1) is as follows: 5 in pure word list and 6 in mixed word list; 5 in pure picture list and 5 in mixed picture list. The allocation of 19 participants to conditions in English (L2) is as follows: 5 in pure word list and 4 in mixed word list; 6 in pure picture list and 4 in mixed picture list.

Materials

The 50 pictures and picture names (words) used in Russian were the same as in Experiment 1. The items' corresponding English translations were matched to the AoA English norms using Snodgrass and Vanderwart (1980) and the colour version picture norms (Rossion and Pourtois, 2004). Rating data collected for English (L2) at the end of the experiment were used in correlational analyses reported below to ensure that items were reliably corresponded with early and late AoA.

For bilingual participants, significant correlations were found in English (L2) AoA picture ratings between the current study and the English norms reported by Tsaparina et al (2011) [$r(50)=0.51$ $p<0.0001$]; the original Snodgrass and Vanderwart (1980) [$r(47)=0.55$ $p<0.0001$] as well as Cortese and Khanna (2008) [$r(41)=0.51$ $p<0.005$] thereby reconfirming the robustness of AoA across a variety of measures.

Procedure

The procedure was the same as in Experiment 1. Stimuli were again 50 pictures and picture names (words) presented either in a pure or mixed block design for free recall. Half of the participants were presented with the experimental task in Russian (L1) and other half in English (L2).

As in Experiment 1, after the experimental task was completed each participant was asked to rate the age at which they acquired a particular picture either in Russian (L1) or in English (L2). Allocation to AoA rating was based on which experimental condition the

participants were allocated. Therefore, participants who completed the free recall task in Russian (L1) rated AoA in Russian and those who completed the free recall task in English (L2) rated AoA in English. The collection of AoA ratings in L1 and L2 were used to further evaluate the reliability and the validity of the Russian normative data on AoA (Tsaparina et al, 2011).

Results

The data were analysed using descriptive statistics and a 2 (AoA: Early, Late) x 2 (Stimulus language: Russian – English) x 2 (Stimulus type: Picture, picture name/word) x 2 (List type: pure, mixed) mixed ANOVA.

As can be seen in Table 2, recall of early words and pictures were superior to late words and late pictures irrespective of list type. The findings are contrary to those reported in English (Dewhurst et al, 1998) for monolinguals and line with the findings reported in Turkish (Raman et al, 2015; under revision). The ANOVA results showed a robust main effect for AoA effect in free recall irrespective of list type for words [$F(1,19) = 9.44$ $p < 0.006$)] and for pictures [$F(1,19) = 46.9$ $p < 0.0001$). None of the interactions reached statistical significance. To the best knowledge of the researcher, this is the first report of AoA effect in Russian in a free recall task for words and pictures.

Insert Table 2 here

The descriptive statistics in Experiment 2 reported in Tables 2 and 3 were split into recall scores in Russian (L1) and English (L2) for a simpler presentation. As can be seen in both tables, bilingual Russian (L2) – English (L2) participants showed a similar pattern of results to monolingual Russian participants in Experiment 1. That is, early acquired words and pictures were better recalled than late acquired items overall.

Insert Table 3 here

Interim Discussion

The aim of Experiments 1 and 2 was to investigate if AoA influenced free recall in monolingual and in Russian (L1) – English (L2) bilingual speakers under mixed and pure conditions using pictures and picture names (words).

Data from Experiment 2 were formally analysed using a 2x2x2x2 mixed ANOVA and for the word data, the results showed a reliable main effect for language [$F(1,8) = 49.58$ $p < 0.0001$] but not for AoA [$F < 1$] and a significant interaction between-language and AoA [$F(1,8) = 14.40$ $p < 0.005$]. Post hoc tests showed that while early AoA words were significantly better recalled in Russian (L1) than in English (L2) this was not the case for late AoA words. For

pictures there was also a significant main effect for language [$F(1,8)=86.30$ $p<0.0001$] but this time also for AoA [$F(1,8)=28.60$ $p<0.001$]; none of the interactions reached statistical significance.

It is important to note however that although list type did not yield significant differences, under English (L2) conditions participants overall performed better in recalling words and pictures under the mixed list compared to the pure list condition especially for late items (mean recall of late words in pure list is 2.8 versus 5.2 in mixed list, and late pictures in pure list is 3.2 versus 4.5 in mixed list). Noteworthy is that when participants were required to recall items in Russian (L1) contrary results were found overall with only early items being better recalled under the mixed compared to the pure list condition (mean early word recall 9.8 vs 10.5 respectively). This finding is suggestive that future research could target a mixture of early and late bilinguals where the effect of the mixed list could be maximized.

One of the additional goals of Experiments 1 and 2 were to explore whether the picture AoA ratings from the current study were in line with those reported in the literature (see Appendix for AoA ratings from this study and Russian ratings from others). The rationale for only using pictures for AoA ratings was based on the universal aspect of picture processing which is assumed to be language independent (Raman et al, 2014). This also ensured that rating in Russian (L1) and English (L2) had comparable results between monolingual and bilingual participants. This is an important aspect of AoA experiments as AoA norms are often criticised for being based on subjective ratings (see Morrison and Ellis, 1995 for an overview).

For monolingual participants in Experiment 1, the rating data for 50 items were entered into a correlational analyses using Pearson's which found a significant relationship between the current ratings and Tsaparina et al (2011) AoA norms [$r(50)=0.63$ $p<0.0001$]. Moreover, a significant correlation was also found between the current ratings and those reported recently in a large normative study for 25 languages (Luniewska et al, 2016) for 29 items, $r(29)=0.74$ $p<0.0001$. For bilingual participants in Experiment 2, significant correlations were found in English (L2) AoA picture ratings between the current study and the English norms reported by Tsaparina et al (2011) [$r(50)=0.51$ $p<0.0001$]; the original Snodgrass and Vanderwart (1980) [$r(47)=0.55$ $p<0.0001$] as well as Cortese and Khanna (2008) [$r(41)=0.51$ $p<0.005$]. For bilingual participants, significant correlations were also found in English (L2) AoA picture ratings between the current study and the English norms reported by Tsaparina et al (2011); the original Snodgrass and Vanderwart (1980) as well as Cortese and Khanna (2008). Therefore, the reliability of the items used in Experiments 1 and 2 were confidently established.

General Discussion

The main query in this study was to investigate whether and the extent to which AoA shapes monolingual and bilingual memory. It has been argued in the literature that as a psycholinguistic variable AoA resides within the semantic lexicon. The monolingual data in Experiment 1 showed a significant AoA effect and support the predictions of the semantic hypothesis (Brysbaert et al, 2000) for words and the picture superiority effect in free recall (Paivio, 1971; 2007). The results from Experiment 2 with bilingual Russian (L1) – English (L2) speakers in word recall, showed a main effect for language but not for AoA; while post-hoc tests following a significant interaction between language and AoA found that while early AoA words were significantly better recalled in Russian (L1) than in English (L2) this was not the case for late AoA words. For pictures, main effects were found for both language and AoA. To the best knowledge of the authors, these findings are reported for the first time in the literature shedding light onto understanding how lexico-semantic processes and memory are accessed in monolingual Russian and bilingual Russian (L1) – English (L2) speakers.

Concerns are often raised on the interpretation of AoA effects given its close relationship with frequency. It is important to note that extreme care was taken to ensure that the two variables were as orthogonal as possible at the onset of the study. Stimuli selected from the norms significantly differed on AoA [$F(1,24)=925.35$ $p<0.0001$] while matched on frequency [$F(1,24)=0.83$ $p=0.37$].

One other interesting outcome was the null effect for list type. Despite this, descriptive statistics showed that in English (L2) participants overall performed better in recalling words and pictures under the mixed list compared to the pure list condition especially for late items. Noteworthy is that when participants were required to recall items in Russian (L1), contrary results were found overall with only early items being better recalled under the mixed compared to the pure list condition. Although the direction of this effect is clear, the interpretation of results due to the small sample sizes reported here should be interpreted with due care.

The results from the current study were also contradictory to the results of an earlier free recall task conducted by Lambert and colleagues (1968) on English (L1) – French (L2) and English (L1) – Russian (L2) participants. In Lambert's et al study (1968) bilingual speakers were presented with either a pure list (particular semantic categories were in one language while other categories were in the other language) and a mixed list of words (within category items were drawn from both languages). The results showed that bilingual nature of a mixed list does not interfere with the recall of the words from different categories, but can disrupt recall of the words from the same category. However, the results of list effect in the current study showed

that free recall appear not to be under the strategic control of participants. The absence of the list type effect can be explained by the peculiar properties of the bilingual memory of the late Russian (L1) – English (L2) bilinguals who arguable could rely more on the order of the word acquisition rather than the list type in the free recall. Brysbaert and colleagues (2000) argued that the age at which words are acquired could be an important organising factor of the semantic system, i.e. memory, 'The dependence of word meanings on previously acquired meanings and the highly interconnected nature of semantic concepts may be the main reason why the order of acquisition remains the most important organising factor of the semantic system throughout life' (Brysbaert et al, 2000). In this respect, age and order of acquisition of L2 also play important role in semantic priming and can influence the magnitude of priming (Altarriba and Basnight-Brown, 2007). In this respect, our findings are in line with those reported by Izura and Ellis where order of L2 acquisition appears to be a crucial factor. These results can be further explored in future studies with an additional sample of early Russian (L1) – English (L2) bilinguals.

Overall, these findings are in line with the experimental hypotheses which predicted that because L2 words enter into the bilinguals' lexicon later than L1, one cannot expect a comparable or same magnitude of AoA effect under these circumstances. Evidence from pictures show a robust AoA effect since picture processing is assumed to be language independent. The pattern of results are in line with the predictions of the semantic hypothesis (Brysbaert et al, 2000) and are taken to indicate the role of AoA in the ongoing construction of bilingual memory. It appears that even though there may not be L1 specific effects on free recall in L2, L2 speakers differ from monolinguals in terms of the semantic organization of their language processing system.

Conversely, the findings reported here are also partially supported by the account provided by the arbitrary mapping hypothesis. AoA effect is predicted to be magnified under conditions where mappings between input and output are arbitrary compared to when it is non-arbitrary. Insofar as the free recall task and mappings between input and output are concerned, one could argue that they are arbitrary. This is based on the assumption that at least for words the input is orthography/phonology, and that the output is the semantic representation stored in episodic memory. It nevertheless remains to be seen as to why different languages yield different results.

The difference in the AoA effect obtained in Cortese et al (2010; 2015) studies and the results of the current study showed the advantage of early acquired over late acquired items may be explained by the difference in the two tasks. Namely, Cortese et al studies focused on

recognition memory in English speaking sample, while the current study investigated the free recall in late bilingual population. Recognition memory is a subcategory of declarative memory, e.g. an ability to recognise previously recorded items or events, while recall is attributed to the ability to bring the memory of a past event into mind by activating a semantic presentation. In English, the advantage for late acquired items has often been credited to a semantic distinctiveness advantage observed in recognition memory. In order to resolve these seemingly opposing results from English versus Russian perhaps future research should be directed to identify under what conditions and at what stage items become semantically distinct and to what extent it influences other processes.

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References

Akinina, Y., Malyutina, S., Ivanova, M., Iskra, E., Mannova, E., & Dragoy, O. (2015). Russian normative data for 375 action pictures and verbs. *Behavior research methods*, 47(3), 691-707.

Altarriba, J., & Basnight-Brown, D. M. (2007). Methodological considerations in performing semantic-and translation-priming experiments across languages. *Behavior Research Methods*, 39(1), 1-18.

Baluch, B., & Besner, D. (1991). Visual word recognition: Evidence for strategic control of lexical and non-lexical routines in oral reading. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 17, 644-652

Belke, E., Brysbaert, M., Meyer, A. S., & Ghyselinck, M. (2005). Age of acquisition effects in picture naming: evidence for a lexical-semantic competition hypothesis. *Cognition*, *96*(2), B45-B54.

Boles, D. B., Rogers, S., & Wymer, W. (1982). Age of acquisition and visual field asymmetry in word recognition. *Attention, Perception, & Psychophysics*, *32*(5), 486-490.

Brown, G. D., & Watson, F. L. (1987). First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory & Cognition*, *15*(3), 208-216.

Brysbaert, M., Van Wijnendaele, I., & De Deyne, S. (2000). Age-of-acquisition effects in semantic processing tasks. *Acta Psychologica*, *104*(2), 215-226.

Carroll, J. B., & White, M. N. (1973). Word frequency and age of acquisition as determiners of picture-naming latency. *The Quarterly Journal of Experimental Psychology*, *25*(1), 85-95.

Coltheart, V., & Winograd, E. (1986). Word imagery but not age of acquisition affects episodic memory. *Memory & Cognition*, *14*(2), 174-180.

Cortese, M. J., & Khanna, M. M. (2007). Age of acquisition predicts naming and lexical-decision performance above and beyond 22 other predictor variables: An analysis of 2,342 words. *The Quarterly Journal of Experimental Psychology*, *60*(8), 1072-1082.

Cortese, M. J., Khanna, M. M., & Hacker, S. (2010). Recognition memory for 2,578 monosyllabic words. *Memory*, 18(6), 595-609.

Cortese, M. J., McCarty, D. P., & Schock, J. (2015). A mega recognition memory study of 2897 disyllabic words. *The Quarterly Journal of Experimental Psychology*, 68(8), 1489-1501.
Cubberley, P. (2002). *Russian: A linguistic introduction*. Cambridge University Press.

Dewhurst, S. A., Hitch, G. J., & Barry, C. (1998). Separate effects of word frequency and age of acquisition in recognition and recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(2), 284.

Ellis, A. W., & Lambon Ralph, M. A. (2000). Age of acquisition effects in adult lexical processing reflect loss of plasticity in maturing systems: insights from connectionist networks. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 26(5), 1103.

Ellis, H. D., & Young, A. W. (1977). Age-of-acquisition and recognition of nouns presented in the left and right visual fields: A failed hypothesis. *Neuropsychologia*, *15*(6), 825-828.

Frederiksen, J. R., & Kroll, J. F. (1976). Spelling and sound: Approaches to the internal lexicon. Journal of Experimental Psychology: *Human Perception and Performance*, 2(3), 361.

Gerhand, S., & Barry, C. (1998). Word frequency effects in oral reading are not merely age-of-acquisition effects in disguise. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*(2), 267.

Ghyselinck, M., Custers, R., & Brysbaert, M. (2004). The effect of age of acquisition in visual word processing: further evidence for the semantic hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *30*(2), 550.

Gilhooly, K. J., & Logie, R. H. (1980). Age-of-acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behavior Research Methods & Instrumentation*, *12*(4), 395-427.

Gilhooly, K. J., & Logie, R. H. (1981). Word age-of-acquisition, reading latencies and auditory recognition. *Current Psychological Research*, *1*(3-4), 251-262.

Gilhooly, K. J., & Watson, F. L. (1981). Word age-of-acquisition effects: A review.*Current Psychological Reviews*, *1*(3), 269-286.

Grigorenko, E.L. (2012). Влияние индивидуальных особенностей когнитивного развития на овладение навыками чтения и письма младшими школьниками [Influence of individual

characteristics on cognitive development of reading and writing aqcusition of primary school pupils]. *Moscow State University named after Lomonosov Press, Department of Psychology.*

Huebler, F., & Lu, W. (2013). Adult and Youth Literacy: National, regional and global trends, 1985-2015. UNESCO Institute for Statistics.

Izura, C., & Ellis, A. W. (2002). Age of acquisition effects in word recognition and production in first and second languages. *Psicológica*, 23(2), 245-281.

Izura, C., & Ellis, A. W. (2004). Age of acquisition effects in translation judgement tasks. *Journal of Memory and Language*, *50*(2), 165-181.

Johnston, R. A., & Barry, C. (2006). Age of acquisition and lexical processing. *Visual Cognition*, *13*(7-8), 789-845.

Kerek, E. & Niemi, P. (2009a). Russian orthography and learning to read. *Reading in a Foreign Language, Volume 21, No. 1.* ISSN 1539-0578 pp. 1–21

Kerek E. & Niemi P. (2009b). Learning to read in Russian: effects of orthographic complexity. *Journal of Research in Reading, Volume 32-2,* 157–179 ISSN 0141-0423 DOI: 10.1111/j.1467-9817.2008.01390.x

Kornev, A. N., Rakhlin, N., & Grigorenko, E. L. (2010). Dyslexia from a cross-linguistic and cross-cultural perspective: The case of Russian and Russia. Learning Disabilities: A Contemporary Journal, 8(1), 51-78.

Lambert, W. E., Ignatow, M., & Krauthamer, M. (1968). Bilingual organization in free recall. *Journal of Verbal Learning and Verbal Behavior,* 7(1), 207-214.

Lewis, M. B., Gerhand, S., & Ellis, H. D. (2001). Re-evaluating age-of-acquisition effects: are they simply cumulative-frequency effects?. *Cognition*, *78*(2), 189-205.

Łuniewska, M., Haman, E., Armon-Lotem, S., Etenkowski, B., Southwood, F., Anđelković, D., ... & Gagarina, N. (2016). Ratings of age of acquisition of 299 words across 25 languages: Is there a cross-linguistic order of words? *Behavior Research Methods,* 48(3), 1154-1177.

Lupker, S. J., Brown, P., & Colombo, L. (1997). Strategic control in a naming task: Changing routes or changing deadlines?. *Journal of Experimental Psychology-Learning Memory and Cognition*, 23(3), 570-590.

Lyashevskaya, O., & Sharov, S. (2009). The frequency dictionary of modern Russian language. Azbukovnik, Moscow.

Marian, V., Spivey, M., & Hirsch, J. (2003). Shared and separate systems in bilingual language processing: Converging evidence from eyetracking and brain imaging. *Brain and Language*, 86(1), 70-82.

Menenti, L., & Burani, C. (2007). What causes the effect of age of acquisition in lexical processing? *The Quarterly Journal of Experimental Psychology*, *60*(5), 652-660.

Monaghan, J., & Ellis, A. W. (2002a). Age of acquisition and the completeness of phonological representations. *Reading and Writing,* 15(7), 759-788.

Monaghan, J., & Ellis, A. W. (2002b). What exactly interacts with spelling--sound consistency in word naming?. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 28(1), 183.

Morris, P. E. (1981). Age of acquisition, imagery, recall, and the limitations of multiple-regression analysis. *Memory & Cognition*, *9*(3), 277-282.

Morrison, C. M., & Ellis, A. W. (1995). Roles of word frequency and age of acquisition in word naming and lexical decision. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(1), 116.

Morrison, C. M., Ellis, A. W., & Quinlan, P. T. (1992). Age of acquisition, not word frequency, affects object naming, not object recognition. *Memory & Cognition*, *20*(6), 705-714.

Nagy, W., Anderson, R. C., Schommer, M., Scott, J. A., & Stallman, A. C. (1989). Morphological families in the internal lexicon. *Reading Research Quarterly,* 262-282.

Nairne, J. S. (2010). Adaptive memory: Evolutionary constraints on remembering. In B. H. Ross (Ed.), *The psychology of learning and motivation* (Vol. 53, pp. 1–32). Burlington, VT: Academic Press.

Paivio, A. (2007). *Mind and its evolution: A dual coding theoretical approach.* Mahwah, NJ: Erlbaum.

Paivio, A. (1971). *Imagery and verbal processes.* New York, NY: Holt, Rinehart & Winston.

Rajaram, S. (1996). Perceptual effects on remembering: Recollective processes in picture recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 22, 365–377.

Raman, I. (2011). The role of age of acquisition in picture and word naming in dyslexic adults. *British Journal of Psychology*, 102, 328–339.

Raman, I. (2006). On the age of acquisition effects in word naming and orthographic transparency: Mapping specific or universal? *Visual Cognition*, 13(7/8), 1044–1053.

Raman, I., Baluch, B., & Besner, D. (2004). On the control of visual word recognition: Changing routes versus changing deadlines. *Memory and Cognition*, 32(3), 489-500.

Baluch, B., & Besner, D. (1991). Visual word recognition: Evidence for strategic control of lexical and non-lexical routines in oral reading. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 17, 644-652.

Raman, I., Raman, E. & Mertan, B. (2014). A standardised set of 260 pictures for Turkish: Norms of name and image agreement, age of acquisition, visual complexity and conceptual familiarity. *Behavior Research Methods.* 46(2), 588-595.

Raman, I., Raman, E., Ikier, S., Kilecioglu, E., Uzun, D. & Zeyveli, S. (under revision). Differential Effects of Age of Acquisition and Frequency on Memory: Evidence from Free Recall of Pictures and Words in Turkish.

Rochford, G., & Williams, M. (1962). Studies in the development and breakdown of the use of names: I. The relationship between nominal dysphasia and the acquisition of vocabulary in childhood. *Journal of Neurology, Neurosurgery & Psychiatry*.

Rossion, B., & Pourtois, G. (2004). Revisiting Snodgrass and Vanderwart's object pictorial set: The role of surface detail in basic-level object recognition. *Perception,* 33(2), 217-236.

Schonell, F. J. (1971). Reading and Spelling Tests. Edinburgh: Oliver and Boyd.

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of experimental psychology: Human learning and memory*, 6(2), 174.

Tsaparina, D., Bonin, P., & Méot, A. (2011). Russian norms for name agreement, image agreement for the colorized version of the Snodgrass and Vanderwart pictures and age of acquisition, conceptual familiarity, and imageability scores for modal object names. *Behavior Research Methods*, 43(4), 1085-1099.

Zevin, J. D., & Seidenberg, M. S. (2002). Age of acquisition effects in word reading and other tasks. *Journal of Memory and language*, *47*(1), 1-29.

Zevin, J. D., & Seidenberg, M. S. (2004). Age-of-acquisition effects in reading aloud: Tests of cumulative frequency and frequency trajectory. *Memory & Cognition*, *32*(1), 31-38.

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words	8.6	1.63	11	8.6	1.58	10
Late words	7.5	1.63		6.6	1.90	
Early pictures	10.8	2.4	11	10.6	1.43	10
Late pictures	7	1.9		8.4	2.72	

Table 1: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in monolingual Russian speakers under pure and mixed list types in Experiment 1.

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words in Russian	9.8	0.84	5	10.5	1.52	6
Late words in Russian	6.2	2.2		5.5	2.66	
Early pictures	11.6	1.52	5	10.2	0.84	5
Late pictures	8.4	2.41		6.6	1.52	

Table 2: Mean (in number of recalled stimuli) and their corresponding standard deviations (SD) and number of participants for free-recall task in Russian (L1) in Experiment 2

	List type					
Condition	Pure			Mixed		
	Mean	SD	N	Mean	SD	N
Early words in English	7.6	1.14	5	8	2.2	4
Late words in English	2.8	1.48		5.2	1.26	
Early pictures	5.5	1.38	6	5	1.41	4
Late pictures	3.2	0.98		4.5	1.49	

Table 3: Mean (in number of recalled stimuli), their corresponding standard deviations (SD) and number of participants for free-recall task in English (L2) in Experiment 2

Appendix

AoA ratings from the current study together with Tsaparina et al (2011); Snodgrass and Vanderwart (1980) and Luniewska et al (2016) AoA norms and Frequency Norms

	English	Russian	Ratings from the current study	Tsaparina, Bonin, Meot 2011	Łuniewska et al 2016	Snodgrass Vanderwart 1980	Russian Frequency Tsaparina, 2011	English Frequency SUBTLEX-UK
Early Acquired Words	1. apple	яблоко	1.07	1.26	2.52	1.91	4.47	4.58
	2. ball	мяч	1.12	1.26	2.03	1.34	20.92	5.33
	3. balloon	шарик	1.16	1.45	2.93	2.03	36.12	4.25
	4. bee	пчела	1.07	1.48		2.28	8.27	4.19
	5. book	книга	1.30	1.39		1.83	325.65	5.21
	6. cat	кот	1.02	1.26	2.02	1.36	41.63	4.83
	7. chair	стул	1.19	1.39	2.65	1.86	67.27	4.66
	8. corn	кукуруза	1.51	1.97		2.94	5.47	3.94
	9. cow	корова	1.28	1.35	2.46	1.90	37.38	4.44
	10. cup	чашка	1.09	1.42		1.66	26.83	5.09
	11. dog	собака	1.12	1.39	1.99	1.55	109.45	5.17
	12. doll	кукла	1.09	1.35	2.36	1.55	20.93	4.07
	13. door	дверь	1.23	1.26	2.62	1.97	356.48	5.26
	14. ear	ухо	1.07	1.26	2.34	1.82	113.72	4.41
	15. eye	глаз	1.12	1.23	2.35	2.00	689.57	5.13
	16. flower	цветок	1.14	1.35	2.75	2.15	101.49	4.5
	17. fork	вилка	1.12	1.52	2.79	2.24	12.57	3.97
	18. knife	нож	1.19	1.65	3.32	2.70	56.13	4.49
	19. lion	лев	1.98	1.52	2.92	2.82	10.41	4.45
	20. rabbit	кролик	1.14	1.48	2.63	2.61	16.38	4.39
	21. shoe	обуви	1.14	1.32	2.39	1.94	31.26	4.15
	22. spoon	ложка	1.02	1.32	2.36	1.97	32.09	4.29
	23. table	стол	1.00	1.35		2.45	314.06	5.1
	24. tree	дерево	1.23	1.32	2.47	2.03	142.45	4.95
	25. window	окно	1.07	1.35		2.28	222.74	4.84
Late Acquired Words	26. accordion	аккордеон	1.84	2.94		4.83	3.47	3.42
	27. airplane	самолет	1.07	1.61	3.55	2.59	13.21	3.15
	28. arrow	стрелка	1.19	2.13		3.97	19.19	3.78
	29. anchor	якорь	2.19	2.26		4.88	24.03	3.67
	30. axe	топор	2.21	2.23	5.57	4.38	20.97	3.85
	31. broom	метла	2.23	1.97	4.29	2.97	5.33	3.56
	32. banana	банан	1.05	1.74	2.73	1.90	6.50	4.21
	33. church	церковь	2.28	2.58		2.62	149.75	5.02
	34. cigar	сигара	1.63	3.81		4.09	5.64	3.59
	35. cigarette	сигарета	2.05	3.32		3.62	45.68	4.11
	36. clothespin	прищепка	1.65	2.06		3.31	0.50	4.36
	37. hammer	молоток	1.98	2.03	4.81	3.55	9.83	4.66
	38. envelope	конверт	1.37	2.35	5.08	3.93	19.53	4.1
	39. glove	перчатка	2.35	2.06		3.12	15.85	3.81
	40. guitar	гитара	2.63	2.48	4.71	5.41	17.23	4.39
	41. kite	змей	2.74	2.45		3.72	64.18	3.89
	42. lamp	лампа	2.65	2.52	3.90	2.72	66.38	4.09
	43. leopard	леопард	2.77	2.03		4.18	2.75	3.08
	44. peacock	павлин	1.51	2.06		5.18	3.39	3.67
	45. penguin	пингвин	1.72	2.10	3.97	5.12	2.80	3.88
	46. pipe	труба	2.12	2.68		4.07	69.13	4.26
	47. screw	винт	1.88	2.74		4.45	1.80	4.06
	48. stove	плита	1.44	2.00	2.72	2.72	30.12	3.67
	49. peach	персик	2.58	1.68		2.79	3.86	3.62
	50. pitcher	кувшин	1.60	2.19		4.07	5.27	2.9